Discussion Paper

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Inventory of non-timber forest product plant and fungal species in the Robson Valley

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Abstract

Increasing interest in non-timber forest products (NTFPs) has led to their greater recognition in sustainable forest management planning. This is evident in local resource management plans for the Robson Valley in east-central British Columbia, where public input shows strong support for the sustainable development of NTFP harvesting. However, information needed to develop sustainable management guidelines for NTFPs is currently lacking. We, therefore, undertook an inventory of non-timber forest product plant and fungal species in the Robson Valley.

The distribution and abundance of NTFP plant species was determined by ecosystem types as described by the Biogeoclimatic Ecosystem Classification system used in British Columbia. Species with a relatively high abundance and commercial potential included the valuable medicinal plant Devil's club (*Oplopanax horridus*), berry-producing species such as black huckleberry (*Vaccinium membranaceum*), and the edible ostrich fern (*Matteuccia struthiopteris*). Plants used for floral greenery that are relatively abundant in certain ecosystem types included falsebox (*Paxistima myrsinites*), tall Oregon-grape (*Mahonia aquifolium*), pearly everlasting (*Anaphalis margaritacea*), and conifer boughs, especially from western redcedar (*Thuja plicata*). We identified a number of fungal species noted for their food, medicinal, wildcrafting, industrial, or traditional uses. Among the important food mushrooms we recorded in the Robson Valley were pine mushroom (*Tricholoma magnivelare*), hedgehog mushroom (*Hydnum repandum*), and black morel (*Morchella elata*).

Several information gaps were identified. We recommend that future research focus on gathering detailed information about selected NTFP species. Information describing habitats, growth requirements, production levels, and response to harvesting is needed to develop sustainable management strategies.

KEYWORDS: *non-timber forest products, Robson Valley, inventory, biogeoclimatic ecosystem classification, plants, fungi.*

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Introduction[1]

Non-timber forest products—also referred to as non-wood forest products, botanical forest products, or special forest products—include a wide range of plant and fungal species that have commercial, recreational, and traditional cultural values. They are used for food, medicine, land restoration and beautification, floral greenery, and crafting (deGeus 1995; Atwood 1998; Wills and Lipsey 1999).

We investigated non-timber forest products (NTFPs) in the Robson Valley Forest District as part of the Robson Valley Enhanced Forest Management Pilot Project. This pilot was conceived to: "achieve and maintain the most complete and full value of forest resources possible to the benefit of the communities, industries, and government by purposeful design (strategic to operational) and management" (Robson Valley Enhanced Forest Management Pilot Project 2000).

Non-timber forest products are becoming increasingly recognized by the public and in forest management planning. Communities that traditionally depended on forest resources are seeking economic alternatives to timber. However, harvesting NTFPs is largely unregulated in British Columbia; this may have serious consequences if resources are over-exploited and conflicts develop between different user groups (Turner 2001). Land managers are challenged to optimize the production of timber *and* non-timber resources in a way that is both sustainable and equitable. The Robson Valley Land and Resource Management Plan (LRMP) (Robson Valley Round Table 1999), for example, supports the sustainable development of NTFP harvesting. The plan was developed through a local planning process involving representatives from various sectors and government agencies and it provides direction for the management of all Crown land in the area for the next 10 years. It recognizes the economic, social, and ecological importance of NTFPs and makes specific recommendations to include them in timber management plans.

[1] This report is not a harvesting guide for wild plants and fungi. Some plants and fungi are poisonous and require expert identification. Certain non-timber forest product species may also be traditionally important to local First Nations. Traditional rights should be respected in using NTFP resources. No harvesting should be done in parks or protected areas or on private lands without prior consent from the landowner.

Accurate inventory information is required to ensure the sustainable management of NTFPs in the Robson Valley and elsewhere in British Columbia. Although detailed inventories are integral to the development of timber resources, the development of NTFP resources has not yet been guided by formal inventories. Inventories that identify the full suite of NTFP opportunities and that provide information on their distribution, abundance, quality, and growth characteristics are needed.

Accurate inventory information is required to ensure the sustainable management of non-timber forest products in the Robson Valley and elsewhere in British Columbia.

Because no standard methodologies exist for conducting inventories of NTFPs, we explored an inventory protocol in the Robson Valley that may be applied elsewhere in British Columbia. Inventory techniques vary according to the life form, and spatial and temporal distributions of the species of interest. For small parcels of land with relatively few species, it may be feasible to complete an inventory by sampling the entire area. However, for large and diverse areas where information on a wide range of NTFP species is desired, a statistically rigorous inventory would be prohibitively time-consuming. A more feasible approach is to relate the occurrence of NTFP species to information in existing inventories. British Columbia uses the Biogeoclimatic Ecosystem Classification (BEC) system to delineate sites across the landscape with potential for similar vegetation, according to climatic and environmental properties. Ecosystem mapping, combined with forest cover inventories that show the current distribution of the dominant vegetation communities, can provide a framework for building an inventory of NTFPs.

Our approach was to first gather all available data that might be useful in determining the distribution and abundance of NTFPs in the Robson Valley. For NTFP plants, we compiled all available data sets into a single database. Data included estimates of percent cover as a measure of abundance for a species identified in each particular ecosystem type (i.e., site series described in BEC). The database was queried with a list of known and potential NTFP plant species for British Columbia that was developed through literature review and consultation with buyers and distributors of NTFPs. Relevant data were summarized and used to derive initial estimates of abundance (percent cover) for each NTFP plant species by ecosystem type. Since virtually no information was available for NTFP fungal species, we conducted our own field investigations. We gathered data on their occurrence and habitat preferences, but did not attempt to quantify their relative abundance by ecosystem type. Consequently, we discuss the major groupings of "plants" and "fungi" in two sections. We then look at some of the information gaps and future research needs required to develop effective sustainable management strategies for both NTFP plant and fungal species.

Project Scope

The purpose of this project was to explore an inventory approach to identifying NTFP resource opportunities and their habitat attributes. This approach can be used for operational planning within the defined area of the Robson Valley Forest District[2] as well as elsewhere in British Columbia. Numerous issues surrounding the harvest of NTFPs will need to be addressed for the emerging industry. Each NTFP species possesses its own complex set of economic, ecological, and social aspects related to harvesting. Tedder *et al.* (2002) provided an in-depth analysis of property rights and the institutional framework of the industry, including First Nations rights, tenure issues, and law related to the stewardship of these resources. An increase in our understanding of NTFP species' ecology and biology, production rates, distribution, and abundance is necessary to develop effective sustainable management strategies for these species. In conjunction with the economic and social aspects of the industry, knowledge of these biological factors is required to define sustainable harvesting limits and determine how NTFPs can be integrated into sustainable forest management plans. Although a broad definition of NTFPs might also include forest values such as animal products and ecotourism, we did not include these in this analysis. Because of the variety of species that can occur in an area as large and diverse as the Robson Valley and the short time frame of this project, our inventory results are preliminary. They will, however, serve as a basis for the sustainable management of NTFPs in this area.

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2 Following the 2002 B.C. Ministry of Forests reorganization, the Robson Valley Forest District (previously part of the Prince George Forest Region) was combined with the Clearwater Forest District to become the Headwaters Forest District of the new Southern Interior Forest Region.

Study Area

The Robson Valley Forest District covered approximately 1.4 million hectares of mostly steep mountainous country. The Fraser River runs through the main valley, which consists of wide, open farmland. Alpine and subalpine ecosystems dominate the landscape, with significant areas of forested land occurring on mid- to lower slopes. A wide spectrum of climatic conditions results in a diversity of ecosystems associated with the valley's topography.

SECTION 1
Non-timber Forest Product Plants

Methods

Non-timber Forest Product Plant Species List

A list of plant species occurring in British Columbia with known or potential NTFP value was generated from the literature (e.g., deGeus 1995; Von Hagen *et al.* 1996; Atwood 1998; Wills and Lipsey 1999; Tedder *et al.* 2000; Vance *et al.* 2001), along with personal knowledge and anecdotal sources. To make this plant list comprehensive and useful in searching multiple databases for NTFP species, we included scientific names, common names, and British Columbia species codes (after Meidinger *et al.* 2002). Varietal and synonymous plant names were also included to ensure that database searches revealed all records of NTFP plant species. Many references in the literature did not differentiate between species within a genus (e.g., *Carex* spp, *Salix* spp.). To account for this, all species of those NTFP genera that potentially occur in British Columbia were included. Consequently, not all species records on the search list are necessarily distinct or have confirmed NTFP value. As a result, the list overestimates the number of plant species with NTFP potential in the Robson Valley.

Data Collection

We compiled and examined available data sources that could be used to correlate plant species occurrence with ecosystem types in the Robson Valley. Three primary data sources were amalgamated into a single database. The most comprehensive source was the BEC database provided by the Forest Sciences Program of the British Columbia Ministry of Forests (B.C. Ministry of Forests 2000; Will MacKenzie, Research Ecologist, B.C. Ministry of Forests, pers. comm., 2001). It contained mean percent cover of all plant species identified in plots used to develop ecosystem classifications for ecosystem types occurring in the Robson Valley (see Table 1). A database generated from a study on western hemlock looper (Hogget and Negrave 2001) contained percent cover estimates for plant species found in 37 clusters of plots in a range of stands in the ICHwk3 biogeoclimatic variant. A study on the Northern Wetbelt Silviculture Systems Trials (Jull *et al.* 2002) contributed vegetation data from 77 plots in wet, cool, or cold variants in the ICH and ESSF zones in the Robson Valley.

Data Analysis

The comprehensive list of NTFP plant species for British Columbia was cross-referenced with the amalgamated database. The resulting data set was stratified to show average percent cover of NTFP species in plots by BEC subzone, variant, and site series. Subzones are the basic units of classification in the BEC system and represent groups of ecosystems under the influence of the same regional climate (Meidinger and Pojar 1991). Subzones are subdivided into variants to account for significant variations in regional climate. Site series represent the potential vegetation community at successional climax that can arise on sites with equivalent environmental properties.

To address species abundance, we calculated average cover and then prominence value for each NTFP plant species across all samples, by subzones, variants, and site series in the Robson Valley. Prominence values were derived by taking the square root of species constancy (i.e., number of plots per ecosystem type in which a species occurred divided by the total number of plots for that ecosystem type, multiplied by 100) multiplied by the average cover for the species across all plots in that category (from Delong *et al.* 1994). For example, if a species occurred in 100% of sample plots (constancy = 100), with an average cover of 10%, the prominence equals 100.

Selected Non-timber Forest Product Plant Species

We selected plant species with the greatest potential to support sustainable harvests in the Robson Valley from the list of NTFP species identified. Plant species were selected based on their relative abundance (i.e., prominence) in ecosystem types occurring in the Robson

TABLE 1. Biogeoclimatic ecosystem classification subzones and variants identified in the Robson Valley study area

Zone	Subzone and Variant	
Engelmann Spruce Subalpine Fir (ESSF)	ESSFmm1:	Raush Moist Mild ESSF variant
	ESSFmm2:	Robson Moist Mild ESSF variant
	ESSFwc2:	Northern Monashee Wet Cold ESSF variant
	ESSFwc3:	Cariboo Wet Cold ESSF variant
	ESSFwk1:	Cariboo Wet Cool ESSF variant
	ESSFwk2:	Misinchinka Wet Cool ESSF variant
Interior Cedar–Hemlock (ICH)	ICHmm:	Moist Mild ICH subzone
	ICHwk1:	Wells Gray Wet Cool ICH variant
	ICHwk2:	Quesnel Wet Cool ICH variant
	ICHwk3:	Goat Wet Cool ICH variant
Sub-Boreal Spruce (SBS)	SBSdh:	Dry Hot SBS subzone
	SBSvk:	Very Wet Cool SBS subzone
	SBSwk1:	Willow Wet Cool SBS variant

Valley and commercial potential as indicated in a number of sources (e.g., Atwood 1998; Wills and Lipsey 1999; Vance *et al.* 2001). The database was organized by product type: medicinals and nutraceuticals, edibles (berries and vegetables), craft products, floral and greenery products, and landscaping products.

Results and Discussion

Species List

The amalgamated database contained vegetation data for 1600 plots. A large number (559) of plots could not be used because they did not have BEC classifications assigned to them. More than 400 records for NTFP plant species or genera were queried from this database. Constancy of NTFP species across all plots ranged from a single occurrence (0.06%) (e.g., *Cardamine brewerii*) to approximately 65% cover (*Cornus canadensis*). Average cover ranged from 0.001% (*Cardamine brewerii*) to 85% (*Salix farriae*). Prominence across all ecosystem types in the Robson Valley ranged from near zero (*Cardamine brewerii*) to 118 (*Tsuga heterophyla*).

It was clear that the majority of these species were not significant in terms of commercial potential or prominence in the ecosystem types sampled. Selected species or genera with the greatest NTFP potential are listed in order of prominence calculated across all ecosystem types in the Robson Valley (Table 2). The ecosystem type (subzone and variant; site series where data were available) in which a species was relatively most abundant is also noted. Some site series for which we had BEC data were not yet described and lacked numeric designations in provincial field guides for ecological site classification, but were included nonetheless.

Devil's club (*Oplopanax horridus*) is the most prominent NTFP plant species in the Robson Valley. It is relatively abundant across a range of ecosystem types and, not surprisingly, was most abundant in the ICHwk3/05 (Devil's club–Lady Fern) site series (Figure 1). It has been identified as one of the top three economic "best bets" for wild-crafted medicinal plants in British Columbia (the other two are tall Oregon-grape and St. John's wort; Wills and Lipsey 1999). Devil's club is also a significant and revered plant—medicinally and spiritually—for all Coastal and many Interior First Peoples of British Columbia (Lantz 2000). Other prominent plant species with medicinal value in the Robson Valley include western redcedar (*Thuja plicata*), Sitka valerian (*Valeriana sitchensis*), skunk cabbage (*Lysichiton americanum*), and fireweed (*Epilobium angustifolium*). All of these species have economic potential and are relatively abundant in the ecosystem types that occur in the Robson Valley.

Berry-producing species are also well represented in the Robson Valley. The most prominent species is black huckleberry (*Vaccinium membranaceum*), which is most abundant in the ESSFwc2/03 (Huckleberry–Arnica site series). It is also abundant in the ESSFwk1, ESSFwk2, and SBSvk. Berry picking is an important recreational (and potentially commercial) activity in the Robson Valley. The Robson Valley LRMP (Robson Valley Round Table 1999) recommends a management strategy of identifying and mapping important berry-picking areas for portions of the valley (see Section 2.3.1.2). Our database will help initiate this process.

Another edible plant with commercial potential is ostrich fern (*Matteuccia struthiopteris*), which was most abundant in the SBSvk and ESSFwk2. Ostrich fern produces fiddleheads, which are marketed to gourmet restaurants worldwide, and has been harvested commercially in the Prince George Forest District (Atwood 1998).

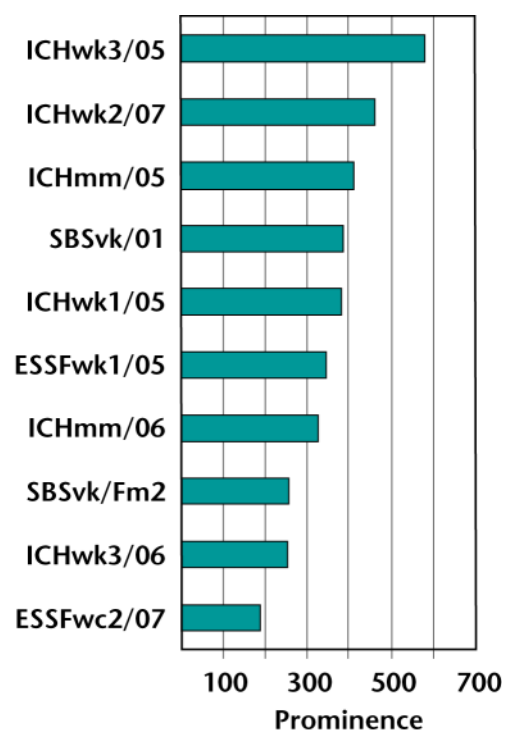

FIGURE 1. Devil's club (*Oplopanax horridus*) prominence by site series.

TABLE 2. Selected non-timber forest product plant species listed in order of prominence[a] across all ecosystem types in the Robson Valley for which there were plot records

Latin name	Common name[b]	Prominence	Product category[c]	Site series[d]
Oplopanax horridus	devil's club	89	M	ICHwk3/05
Thuja plicata	western redcedar	88	M	ICHwk2/07
Sphagnum spp.	peat mosses	69	C, F	ESSFwk, ICHwk
Athyrium filix-femina	lady fern	59	F	ICHwk1, ICHwk2, SBSvk, ESSFwk2
Picea engelmannii	Engelmann spruce	49	F	ICHwk1/06
Cornus canadensis	bunchberry	46	L, M	ICH wk1/03
Vaccinium membranaceum	black huckleberry	40	E	ESSFwc2/03
Dryopteris expansa	spiny wood fern	36	F	SBSvk/05
Matteuccia struthiopteris	ostrich fern	33	E	SBSvk
Valeriana sitchensis	Sitka valerian	32	M	ESSFwc2
Carex spp.	sedges	30	C	wetlands in the ICHwk, SBSvk
Alnus incana	mountain alder	29	M	SBSvk, ICHwk1
Rubus parviflorus	thimbleberry	29	E	ICHmm/UN
Lysichiton americanum	skunk cabbage	28	M	ICHwk1/08
Ledum groenlandicum	Labrador tea	25	M	ICHwk/UN
Spiraea douglasii	hardhack	25	L	SBSvk/Ws3
Vaccinium ovalifolium	oval-leaved blueberry	23	E	ESSFwk2/02
Paxistima myrsinites	falsebox	20	F	ICHmm/02
Cornus stolonifera	red-osier dogwood	18	L, C	ESSFwc2/Fh1
Salix spp.	willows	18	M	SBSvk, ESSFwk
Rhytidiadelphus loreus	lanky moss	12	C, F	ICHwk2
Vaccinium myrtilloides	velvet-leaved blueberry	12	E	ICHwk1/Wb1, SBSvk/02, ICHwk1/03
Rubus chamaemorus	cloudberry	10	E	SBSvk (wetlands)
Epilobium angustifolium	fireweed	10	M	ICHwk2, ESSFwk2 (avalanche tracks)
Chimaphila umbellata	prince's pine	8	M	ICHwk1/03, ICHwk2/03
Arnica latifolia	mountain arnica	8	M	ESSFwc2, wk2
Vaccinium vitis-idaea	lingonberry	7	E	SBSdh/05,02,04
Corylus cornuta	beaked hazelnut	7	C, L	ICHwk1
Urtica dioica	stinging nettle	7	M	ESSFwk/UN, SBSvkFI1
Vaccinium caespitosum	dwarf blueberry	6	E	ESSFwc2/UN, SBSvk/02, ICHwk1/03
Viola spp.	violets	6	L	Variable, depending on the species of interest
Viburnum edule	highbush-cranberry	5	E	SBSdh/07
Pinus monticola	western white pine	5	F	ICHwk1/03
Vaccinium parvifolium	red huckleberry	5	E, F	ICHwk1/04
Oxycoccus oxycoccos	bog cranberry	5	E	ICHwk1/Wb1

TABLE 2. *(Continued)*

Latin name	Common name[b]	Prominence	Product category[c]	Site series[d]
Juniperus communis	common juniper	5	L	ICHwk2/03
Rubus arcticus	nagoonberry	5	E	ICHwk1/06
Rubus idaeus	red raspberry	4	E	SBSvk/UN
Amelanchier alnifolia	Saskatoon	4	E	ICHwk2/05
Lycopodium complanatum	ground-cedar	3	M, C	SBSdh/05
Fragaria virginiana	wild strawberry	3	E	ICHwk2/Wf1
Cladonia spp.	clad lichens	3	C	Variable, depending on the species of interest
Drosera rotundifolia	round-leaved sundew	2	M	SBSvk/Wf4a
Vaccinium scoparium	grouseberry	2	E	ESSFwk2/UN
Anaphalis margaritacea	pearly everlasting	1	F	ESSFwc2/UN
Cladina spp.	reindeer lichens	1	C	ICHwk3/02, wk1/03, wk2/03, SBSdh/02
Achillea millefolium	yarrow	1	M	SBSvk/UN, SBSdh
Mahonia aquifolium	tall Oregon-grape	1	M, F	ICHwk2/03, SBSdh
Adiantum aleuticum	maidenhair fern	1	L	ICHwk1/01

[a] Prominence was calculated by taking the square root of species constancy (number of plots per ecosystem type in which a species occurred divided by the total number of plots for that ecosystem type, multiplied by 100), multiplied by the average cover for the species. This was done across all plots in the database and for each species by subzone, variant, and site series.

[b] Nomenclature follows Meidinger *et al.* (2002).

[c] Product category: M= medicinal and nutraceutical; F= floral and greenery; L = landscaping; E = edible berries and vegetables; C = craft.

[d] Only subzone and variant is listed for some species that were common across a range of site series. Site series are described in Delong (1996). A few site series for which there were data (BEC database, B.C. Ministry of Forests 2000) were not yet described in provincial field guides and do not have numeric designations (e.g., UN = unknown).

The floral and greenery sector commands the greatest value for NTFP plants in British Columbia (deGeus 1995). Of the top 10 floral and greenery species identified by Atwood (1998), falsebox (*Paxistima myrsinites*) and tall Oregon-grape (*Mahonia aquifolium*) might have commercial potential in the Robson Valley. Other prominent floral and greenery species include pearly everlasting (*Anaphalis margaritacea*) and conifer boughs, especially from western redcedar. Cedar is very abundant in the Robson Valley and has many uses other than for timber. Oil extracted from cedar boughs or chips can be quite valuable (Wills and Lipsey 1999).

Native plants used for landscaping purposes that are relatively abundant in the Robson Valley include lady fern (*Athyrium filix-femina*), bunchberry (*Cornus canadensis*), and red-osier dogwood (*Cornus stolonifera*). Juniper (*Juniperus communis*), Pacific ninebark (*Physocarpus capitatus*), and maidenhair fern (*Adiantum aleuticum*) are also locally abundant on some sites. Willows (*Salix* spp.) and red-osier dogwood are used in bioengineering applications to stabilize slopes subject to erosion. Because harvesting for landscaping applications generally requires extraction of whole plants, it should be restricted to salvage situations where roads or other forest developments will permanently displace these plants from a site. However, willow for slope rehabilitation can be taken as cuttings, so it might be amenable to non-salvage situations.

Given the myriad applications of plants in the crafts industry, it would be difficult to determine all of the species that are used. Willows and red-osier dogwood are used in furniture making. Some lichens (e.g., *Cladina* spp., *Evernia* spp.) are harvested for bulk craft supplies. Mosses are used for packaging, crafts, and horticulture (e.g., hanging baskets) (Vance *et al.* 2001). In addition, many different species of the same genera are used, and the industry does not necessarily discriminate. For example, over 20 species of peat moss

(*Sphagnum* spp.) occur in our database. Peat mosses are generally abundant in wetlands in the ESSF and ICH zones. Lanky moss (*Rhytidiadelphus loreus*), a preferred species in the craft industry owing to its growth characteristics, was relatively abundant in the ICHwk subzone. However, commercial moss harvesting does raise concerns about sustainability (Peck and Muir 2001). Mosses are slow growing and large-scale, unregulated harvesting could negatively affect the supporting ecosystems. As with many NTFP plants, more information on growth characteristics and biomass accumulation is required before sustainable harvest limits can be defined.

SECTION 2
Non-timber Forest Product Fungi

Methods

Non-timber Forest Product Fungal Species List

Similar to the NTFP plant list, we developed a list of NTFP fungal species known to occur in British Columbia. Approximately 50 species are reportedly purchased by mushroom buyers in British Columbia (Berch and Cocksedge 2003). These fungi can be grouped into four categories according to their value for:

- food, medicine, and nutraceuticals (deGeus 1995; Wills and Lipsey 1999);
- wildcrafting materials, including natural dyes (Arora 1991);
- industrial applications; or
- traditional uses by Indigenous peoples, such as using woody polypores for carving and as tinder (e.g., Arora 1986; Blanchette *et al.* 1992).

Food mushrooms currently account for the largest volume and value of NTFP mushroom harvests. Of these, pine mushroom (or American matsutake: *Tricholoma magnivelare*), Pacific golden chanterelle (*Cantharellus formosus*), and hedgehog mushroom (*Hydnum repandum*) account for the largest volumes reported by buyers in British Columbia (Berch and Cocksedge 2003).

Data Collection

Since we were not aware of any previous studies on NTFP fungal species in the Robson Valley Forest District, we conducted field investigations to gather data on their occurrence and habitat preferences. We knew that commercial pine mushroom harvests occurred in the area. Additionally, we were told about some rather large black morel (*Morchella elata*) harvests following recent forest fires (B.C. Ministry of Forests staff, Robson Valley Forest District, pers. comm., 2000).

To supplement this limited information, we enlisted several mycologists and co-ordinated field trips (fall of 2000 and spring and fall of 2001) to identify NTFP fungal species and describe their habitats. We focused on locating fungal species that were on our NTFP species list and searching a range of ecosystem types.

We described site, forest cover, and ecosystem characteristics where NTFP mushrooms were found. Site locations were geographically referenced with a hand-held global positioning system (GPS) unit. Notes were taken on the fruiting substrate, associated tree species, site disturbance, and other features. We also documented many fungi other than those on our NTFP list that had not previously been recorded for the Robson Valley or surrounding area. This information increases the general knowledge of fungus distributions in British Columbia. Voucher specimens for all of the identifiable fungi we collected were deposited into the fungal collection at the Pacific Forestry Centre (Pacific Forestry Centre 2003).

We described a number of productive pine mushroom sites because it was the most significant commercially harvested NTFP we identified in the Robson Valley, and we had relative success in locating productive habitat. Productive pine mushroom habitat has been characterized elsewhere in British Columbia (e.g., Berch and Wiensczyk 2001; Ehlers and Fredrickson 2001; Kranabetter *et al.* 2002). This information was applied to the Robson Valley using a combination of forest cover, BEC, and topographic maps supplied by the B.C. Ministry of Forests to locate productive pine mushroom habitat.

Results and Discussion

Species List

Approximately 200 fungal species were identified and vouchered from various ecosystem types in the Robson Valley. Habitats were described for 5 NTFP species found during the spring (Table 3) and 24 NTFP species found during the fall (Table 4) sampling periods. With the exception of pine mushroom, we had no information about where fungi might be most abundant; the habitat information we provide describes only the sites where they were found and not necessarily the habitat in which they were most abundant. We did not attempt to quantify NTFP fungal species abundance by ecosystem type. Such estimates would require intensive sampling

TABLE 3. Non-timber forest product mushroom species found during spring forays in the Robson Valley

Latin name	Common name[a]	Product category[b]	BEC subzone/variant	Forest cover[c]	Age class[d]
Gyromitra esculenta	false morel	E[e]	ICHmm	Pl (Fd, At)	4, 5
			SBSdh	Pl	5, 6
				At (Pl)	4, 5
			SBSdh–(ICHmm)	Sx (Pl, Fd, Act)	4, 5
Morchella esculenta	yellow morel	E	ICHmm	Fd (Ep, Pl)	5
Morchella elata	black morel	E	ESSFmm1	Sx, Bl, At (Act)	7
			ICHmm	Pl (Fd, At)	5
				At, Pl, Ep (Se)	3, 4
				Fd (Ep, Pl)	5
				Pl, Fd	5
			SBSdh	Pl	5, 6
				Fd (Ep, Pl)	5
				Pl (Fd, At)	4, 5
Pleurotus ostreatus	oyster mushroom	E	SBSdh–(ICHmm)	Pl (At, Se)	5
Suillus lakei	Western painted slippery jack	E	SBSdh	Pl (Fd, At)	4, 5

[a] Common names based on Arora (1986).

[b] Product category: E = edible.

[c] B.C. Ministry of Forests Species codes: Act = *Populus balsamifera* ssp. *trichocarpa*; At = *Populus tremuloides*; Bl = *Abies lasiocarpa*; Cw = *Thuja plicata*; Fd = *Pseudotsuga menziesii*; Hw = *Tsuga heterophyla*; Pl = *Pinus contorta*; Sx = *Picea* cross.

[d] B.C. Ministry of Forests age classes in years: 1 = < 20; 2 = 21–40; 3 = 41–60; 4 = 61–80; 5 = 81–100; 6 = 101–120; 7 = 121–140; 8 = 141–250; 9 = 250+.

[e] Though some people eat this species, it is not recommended for consumption as it can be deadly poisonous when raw, and may contain carcinogens even after being cooked.

TABLE 4. Non-timber forest product mushroom species found during fall forays in the Robson Valley

Latin name	Common name[a]	Product category[b]	BEC subzone/variant	Forest cover[c]	Age class[d]
Armillaria ostoyae and others	honey mushroom	E[e]	ICHmm	Pl, Fd, Bl (Sx, At)	2
Auricularia auricula	wood ear; tree ear	E	ICHwk3	Ep, Bl	6
Boletopsis subsquamosus	kurokawa	M	SBSdh	Pl (At)	4
Boletus mirabilis	admirable bolete	E	ICHmm	Hw, Cw	9
			ICHmm	Fd, Hw, Pl, Cw	5
			ICHwk3		8
Coprinus comatus	shaggy mane	E	N/A	lawn	non-forested
Craterellus tubaeformis	winter chanterelle	E	ICH mm	Fd, Hw, Pl, Cw	5
			ICHwk3	Pl, Hw, Cw, Sx	8
Fomes fomentarius	tinder polypore	O	ICHwk3–(SBSdh)	Sx, Bl (Hw)	6
Fomitopsis pinicola	red-belted conk	M	ICHwk3	Sx, Bl (Hw)	6
Gloeophylum saepiarium	rusty gilled polypore	O	ICHwk3	Sx, Pl	6
			SBSdh	downed Pl log	6
Hericium sp.	coral hericium	E	Riparian (Fraser R.)	Act log	—

TABLE 4. *(Continued)*

Latin name	Common name[a]	Product category[b]	BEC subzone/variant	Forest cover[c]	Age class[d]
Hydnum repandum	hedgehog mushroom	E	ICHmm	Fd, Hw, Pl, Cw	5
			ESSFmm1	Sx, Bl	5
			ICHwk3	Sx, Cw, Hw	8
			ICHwk3–(ESSFwk1)	Bl, Sx (Cw)	8
Inonotus obliquus	chaga	M	various	Ep	5
Lactarius deliciosus	delicious milk cap	E	SBSdh	Pl (At) *OR*	4
			ICHmm	Pl, Fd(S At)	2
			SBSdh	Pl	6
Lycoperdon perlatum	common puffball	E	ESSFmm1		
			ICHmm	Fd, Hw (Sx, Cw, At)	3
			SBSdh	Pl (At) *OR*	4
			SBSdh	Pl (At) *OR*	4
Lyophyllum decastes	fried chicken mushroom	E	ICHmm	Hw Cw	9
Polyporus spp.	polypores	M, O	various trees	on wood, standing mature forests	
Rozites caperata	gypsy mushroom	E, M	ICHmm	Hw, Cw	9
			ICHwk3		8
Russula xerampelina	shrimp russula	E	ICHwk3		8
Suillus brevipes	short-stemmed slippery jack	E	ESSFmm1	Sx, Bl	5
Suillus granulatus	granulated slippery jack	E	SBSdh	Pl (At) *OR*	4
			SBSdh	Pl	6
Suillus lakei	western painted suillus	E	ICHwk3	Hw, Bl, Sx, Fd	5
		E	ICHwk3	Pl, Hw, Cw, Sx	8
Suillus tomentosus	blue-staining slippery jack	E	ICHmm	Fd, Hw, Pl, Cw	5
			SBSdh	Pl (At) *OR*	4
			SBSdh	Pl	6
Tricholoma caligatum	booted tricholoma	E	ICHmm	Fd, Hw (Sx, Cw, At)	3
			ICHwk3	Hw, Bl, Sx, Fd	5
			SBSdh	Fd, Pl	5,6
Tricholoma magnivelare	pine mushroom	E	ICHmm	Fd, Hw, Pl, Cw	5
			SBSdh	Pl (At) *OR*	4
			SBSdh	Pl (At) *OR*	4
			SBSdh	Pl	6

[a] Common names based on Arora (1986).

[b] Product category: E = edible; M = medicinal; O = other.

[c] B.C. Ministry of Forests Species codes: Act = *Populus balsamifera* ssp. *trichocarpa*; At = *Populus tremuloides*; Bl = *Abies lasiocarpa*; Cw = *Thuja plicata*; Fd = *Pseudotsuga menziesii*; Hw = *Tsuga heterophyla*; Pl = *Pinus contorta*; Sx = *Picea* cross.

[d] B.C. Ministry of Forests age classes in years: 1 = < 20; 2 = 21–40; 3 = 41–60; 4 = 61–80; 5 = 81–100; 6 = 101–120; 7 = 121–140; 8 = 141–250; 9 = 250+.

[e] Edible with caution; sometimes causes stomach upsets.

with multiple site visits over a decade or more to account for seasonal and year-to-year variation in production.

Because some mushrooms are poisonous, we do not encourage people to harvest and eat these fungi unless they are sure of the species being harvested. It is easy for the non-expert to misidentify fungi. Because the fungi of British Columbia are so poorly known, even the expert encounters fungi not previously identified. Even fungi that are correctly identified and known to be edible can sometimes cause adverse reactions when ingested by some people.

Some fungi on our list are as hard as wood and are consequently inedible; however, these fungi have medicinal or other useful properties (e.g., tinder polypore [*Fomes fomentarius*], red-belted conk [*Fomitopsis pinicola*], and rusty gilled polypore [*Gloeophylum saepiarium*]). Tinder polypore has traditionally been used as tinder and in the production of a leather-like substance. Rusty gilled polypore has industrial potential for the production of wood-decay enzymes and antifungal agents. Red-belted conk has reported use as a tonic to increase disease resistance and fight cancer (Hobbs 1995).

The most commercially important NTFP food mushrooms that we found included black morel, pine mushroom, hedgehog mushroom, and winter chanterelle (*Craterellus tubaeformis*). Black morel was reportedly harvested in commercial quantities following a large fire that swept through the Dore River Valley (B.C. Ministry of Forests staff, Robson Valley Forest District, pers. comm., 2000). We found it in minor amounts across a range of age classes on relatively dry, mostly disturbed sites from valley bottom to subalpine locations (Table 3). There were no reports of commercial harvesting of hedgehog mushroom or winter chanterelle. These species were found in relatively high abundance on some sites in association with mature (> 80 years) forests primarily in the ICHmm and ICHwk3 (Table 4). Another NTFP species on our list was the false morel, or brain mushroom (*Gyromitra esculenta*), which has been commercially harvested in the province (primarily for eastern European markets). It contains a deadly toxin when raw that is eliminated through drying or cooking (Arora 1991). This species was notably abundant in even-aged, mature lodgepole pine-dominated forests in the SBSdh at lower elevations within the study area (Table 3).

Most commercially important mushrooms are associated with trees in mutually beneficial associations called mycorrhizae. Mycorrhizal mushroom species stop fruiting after timber harvesting because their mycorrhizal partner has been removed. Although these mushrooms often recolonize regenerating stands, it takes 40–80 years or more for the fungi to regain abundance. To manage a landscape for timber and NTFP mycorrhizal mushrooms would require the development of plans that integrate the most productive habitat types for the species involved. The Robson Valley LRMP (Robson Valley Round Table 1999) recommends that pine mushroom habitat be identified, mapped, and managed within designated areas. From our investigations, we now have initial pine mushroom habitat information for the Robson Valley to begin an integrated management process. Table 5 summarizes pine mushroom habitat attributes in the Robson Valley.

TABLE 5. Characteristics of productive pine mushroom (*Tricholoma magnivelare*) habitat in the Robson Valley

Forest Cover

Stand Age: 100–120 years

Dominant Tree Species: Lodgepole pine dominated, or mixed western hemlock and Douglas-fir.

Biogeoclimatic Ecosystem Classification

Subzone: Dry Hot Sub-boreal Spruce (SBSdh)
Site Series: 01, 04

Subzone: Moist Mild Interior Cedar–Hemlock (ICHmm)
Site Series: 01, 03

Associated Understorey Vegetation

Generally very sparse; blueberry (*Vaccinium* spp.), prince's pine (*Chimaphila umbellata*) often present. Moss cover is variable, usually dominated by red-stemmed feathermoss (*Pleurozium schreberi*).

Site Characteristics

General: Thin forest floors; well-drained and infertile soils; coarse-textured soils that allow for rapid percolation; often along glacio-fluvial terraces and ridges, undulating morainal blankets, and aeolian (dune) habitats.

Soil Moisture Regime: 2–4 (subxeric to mesic)

Soil Nutrient Regime: B (Poor)

Study Limitations

Our ability to accurately quantify and map NTFP resources in the Robson Valley is currently limited by several factors. The use of BEC data has some inherent limitations for an inventory of this nature. These data were collected from representative ecosystems that might not reflect local variations in plant communities associated with the ecosystems in the Robson Valley.

For plant species, we have better data for some site series and variants than for others. Sampling intensity for BEC is variable according to the areal extent of the ecosystem, its apparent diversity, and its importance for forestry or range management, as well as accessibility (Meidinger and Pojar 1991). Percent cover of patchily distributed plant species may vary considerably within a site series, and too few samples may have been obtained to properly account for this variation. We also lack data for plant communities associated with younger forest types; sampling for BEC has traditionally focused on mature-to-climax ecosystems. Because of this, we were only able to consider older age classes at this time. Many NTFP species are pioneer species found in early successional stages. Fireweed (*Epilobium angustifolium*), for example, is abundant following disturbance on some sites, but relatively rare in later successional stages.

We must also consider the utility of using mean cover as a measure of abundance. Mean cover may not correspond well with commercial yield of a product. Salal (*Gaultheria shallon*), for example, is often an abundant NTFP species in coastal ecosystems, but commercial-grade salal is not necessarily associated with the highest mean cover (Fredrickson 1999). For these NTFP species, data that are more specific are required to determine the factors that influence quality and value.

Mushrooms present a unique set of challenges to inventory. Fungi are very diverse, occupying a wide variety of microhabitats and serving many different functional roles in the ecosystem. Their fruiting is often ephemeral, and varies both spatially and temporally. Our knowledge of the distribution and habitat relationships for British Columbia fungi is limited—less than 1% of the macrofungi have been documented through formal systematic study for over 90% of British Columbia (Redhead 1997).

Several years of data collection and multiple sampling visits throughout the fruiting season are required to account for the high annual and seasonal variation in mushroom fruiting patterns. Survey techniques rely on the presence of mushrooms, which only fruit under the right conditions. Surveys must be timed to coincide with fruiting periods. Our sampling was conducted on three different occasions, twice in the fall in consecutive years, and once in the spring. We would need to sample more frequently over more years to identify the most consistently productive habitats for each species and to accurately estimate production levels.

Fungi are very diverse, occupying a wide variety of microhabitats and serving many different functional roles in the ecosystem.

Detailed ecosystem mapping that delineates BEC site series across the landscape would enable more accurate mapping of the potential habitats of plant and fungal NTFP species.

Ecosystem mapping in the Robson Valley is, for the most part, currently limited to the subzone and variant level. Detailed ecosystem mapping that delineates BEC site series across the landscape would enable more accurate mapping of the potential habitats of plant and fungal NTFP species. Site series describe the potential vegetation that can occur on a site with given environmental properties over time. Forest cover maps reflect the current vegetation community condition on a site. In combination, these two mapping tools could be used to predict the distribution and abundance of suitable habitat for NTFPs, provided there is sufficient data to correlate NTFP occurrence and productivity with different habitat types. This approach has been demonstrated on northern Vancouver Island (Ehlers and Fredrickson 2002). With a better understanding of the biology and ecology of individual NTFP species, these tools could be used to model NTFP production under different management scenarios.

Future Research

A large number of potential NTFP plant and fungal species were identified in this inventory; future studies should focus on developing more detailed species-specific inventories. Turner (2001) outlined principles for the sustainable harvesting of NTFPs that include general, ecological and biological, harvesting, cultural and social, and marketing and economic factors. Following these principles, we need to create specific guidelines for individual species. No single management approach can be applied effectively to address the complex ecological, economic, and social characteristics of multiple NTFPs (Tedder *et al.* 2002). Selection of

NTFP species for management should be based on their potential, as well as current, demand. Species subject to the greatest harvesting pressure, or that are sensitive to harvesting, should be considered. In British Columbia, the edible food mushrooms, floral greenery, and berry plants are at the forefront of the commercial NTFP industry (deGeus 1995; Atwood 1998). We have identified some potential candidate NTFP species in these categories for future study, given their relative abundance in ecosystem types in the Robson Valley. Future studies should include sampling designs to test and strengthen the BEC site series and forest cover correlations with NTFP species abundance. Data should be collected that enhance our understanding of reproduction strategies, growth rates, ecosystem interactions, and productivity for these species. With detailed ecosystem mapping and knowledge of NTFP species habitat characteristics, productive habitats for selected species could then be mapped using Geographic Information System mapping platforms. Once production levels or commercial yields (e.g., kg/ha per year of berries or mushrooms) have been determined, we can better define sustainable harvest levels and economic values of NTFP resources.

Co-management techniques that optimize the production of both timber and non-timber resources need to be explored.

Co-management techniques that optimize the production of both timber and non-timber resources need to be explored. Numerous studies in the Pacific Northwest United States have examined forest management and commercial mushroom harvests. For instance, there is evidence that on some sites stand treatments designed to enhance pine mushroom production can simultaneously sustain high-quality timber production (Weigand 1998). In British Columbia, Wiensczyk *et al.* (2002) outlined current research on forest management practices to maintain mycorrhizal fungal diversity that has implications for managing commercial mushroom species. Partial cutting strategies that retain some stand structure, limit opening size, minimize forest floor disturbance, and encourage a mixture of tree species are recommended. Fire has long been used by First Nations in British Columbia to improve berry production (Turner 1991). As a final example, trials on northern Vancouver Island have successfully demonstrated the economic feasibility of salvaging native plants, ferns in this case, from proposed roadways that will permanently displace these plants (Cocksedge 2003).

Conclusions

This inventory identifies a wide range of NTFP plant and fungal species that occur in the Robson Valley. It indicates in which ecosystem types certain NTFP species are most likely to be found. We provide baseline information and a framework for future inventory of NTFP species in the Robson Valley and elsewhere in British Columbia. Linking NTFP species to the Biogeoclimatic Ecosystem Classification system will facilitate their integration into resource management planning throughout British Columbia.

The NTFP plant species inventory is limited to predicting the distribution and relative abundance of species in mature forest types by BEC subzones and site series in the Robson Valley. Since the majority of forested lands within the District's timber harvesting land base are currently mature, this is helpful. Immature stands that might have NTFP potential will require additional data collection. For NTFP fungal species, our results are limited because existing inventory information linking fungal species distributions to BEC classification and age class is sparse. Our investigations confirm that some valuable NTFP fungal species are available for harvesting in the Robson Valley, but we have no data for commercial abundance at this time.

This inventory provides baseline information for harvesters wishing to explore commercial opportunities with NTFPs in the Robson Valley. The species reported here cover a broad spectrum of products and a corresponding diversity of markets. Not all of the species we identified are commercially viable for harvest in the valley. For most people involved in harvesting NTFPs, it is an enjoyable activity that connects them with nature and supplements their income.

As detailed ecosystem mapping becomes available for the entire Robson Valley, it can be used to map productive habitats for NTFP species that we have identified. We recommend more detailed studies of select NTFP species to relate abundance to ecosystem types over a range of forest age classes. Further research is needed to predict NTFP species' responses to management actions and to design optimal silvicultural prescriptions that sustain or enhance NTFP species under a range of management scenarios.

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